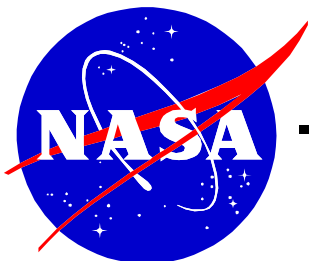


**GAMMA-RAY LARGE AREA
SPACE TELESCOPE
(GLAST)
PROJECT**

**GLAST BURST MONITOR (GBM)
INSTRUMENT – SPACECRAFT
INTERFACE REQUIREMENTS DOCUMENT**

DRAFT

JANUARY 30, 2001



**GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND**

GAMMA-RAY LARGE AREA SPACE TELESCOPE
(GLAST)

PROJECT

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INTERFACE REQUIREMENTS DOCUMENT

JANUARY 29, 2001

NASA Goddard Space Flight Center
Greenbelt, Maryland

GLAST PROJECT GBM INSTRUMENT – SPACECRAFT IRD

Prepared by:

Joy Bretthauer
GLAST Observatory Manager

Date

Reviewed by:

Dr. Charles Meegan

Date

Jeff Hein

Date

Approved by:

Scott Lambros
GLAST Project Manager

Date

Steve Elrod

Date

GBM Project Manager

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ACRONYM LIST

ACS	Attitude Control Subsystem
bps	bits per second
BGO	bismuth germanate
C&DH	Command and Data Handling
CCSDS	Consultative Committee for Space Data Systems
CTDB	Command, Telemetry and Data Bus
Dec	Declination
DPU	Data Processing Unit
EMC	Electromagnetic Compatibility
FOV	Field of View
g	gravity
GBM	GLAST Burst Monitor
GEVS-SE	General Environmental Verification Specification for SDTS and ELV Payloads, Subsystems and Components
GLAST	Gamma-ray Large Area Space Telescope
GPS	Global Positioning System
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
HSFSB	
Hz	Hertz
IGES	International Graphics Exchange Specification
IR	Infrared
IRD	Interface Requirements Document
k	kilo
kg	kilogram
LAT	Large Area Telescope
m	meter
M	Mega
Mil Std	Military Standard
MLI	
PDR	Preliminary Design Review
PPS	Pulse Per Second
RA	Right Ascension
SC	Spacecraft
SI	Science Instrument
sr	Steradian
SRD	Science Requirements Document
STEP	
TBC	
TBD	To Be Determined
TBR	To Be Resolved
TDRSS	Tracking and Data Relay Satellite System
UTC	Universal Coordinated Time
UV	Ultra Violet
V	Volt
W	Watt

1 INTRODUCTION

1.1 PURPOSE

The primary purpose of this Interface Requirements Document (IRD) is to describe and specify the interfaces between the GLAST Burst Monitor (GBM) instrument and the spacecraft. However, it also provides the launch vehicle constraints (TBD) on these system elements and provides design guidelines in certain areas. Environmental estimates for radiation and micrometeoroids are specified in the Mission System Specification. In addition, it assigns certain interface responsibilities.

The current version of this document is the means by which instrument accommodation requirements are communicated to a number of spacecraft study contractors. At the same time it serves to identify the interface standards to which the instrument is designed and to obtain confirmation of them from the spacecraft study contractors.

1.2 RELATION TO OTHER DOCUMENTS

The requirements in this document normally flow down directly to instrument and spacecraft systems from either the Science Requirements Document or the Mission System Specification. In addition, either the Instrument Performance Specification or the Spacecraft Specification may levy peer requirements.

The GBM IRD presently contains some requirements that properly belong in some other documents. At the present time, those requirements are only in this document, and therefore this document must be used as a companion document. As other requirements documents are established and mature, those requirements can be expected to migrate from this document to those documents where they properly belong.

2 APPLICABLE DOCUMENTS

Requirements in this Specification are traceable to the following documents:

GLAST Science Requirements Document

GLAST Mission System Specification

GLAST Spacecraft Performance Specification

GLAST Mission Concept Review Presentation Package, September 28, 1998

Delta II Payload Planners Guide <http://www.boeing.com/defense-space/space/delta/delta2/guide/index.htm>

GEVS-SE Rev A General Environmental Verification Specification for STS & ELV Payloads, Subsystems, and Components <http://arioch.gsfc.nasa.gov/302/gevs-se/toc.htm>

CCSDS 102.0-B-4 Recommendation for Space Data Systems Standards. Packet Telemetry <http://www.ccsds.org/publications.html> - telemetry

CCSDS 202.0-B-2 Recommendation for Space Data Systems Standards.
Telecommand, Part 2: Data Routing Service <http://www.ccsds.org/publications.html> -
[telecommand](#)

CCSDS 203.0-B-1, "Recommendation for Space Data Systems Standards.
Telecommand, Part 3: Data Management Service" CCSDS Recommendation, Blue
Book.

CCSDS 101.0-B-3, "Recommendation for Space Data Systems Standards. Telemetry
Channel Coding." CCSDS Recommendation, Blue Book

CCSDS 201.0-B-2, "Recommendation for Space Data Systems Standards.
Telecommand, Part 1: Channel Service." CCSDS Recommendation, Blue Book.

CCSDS 202.1-B-1, "Recommendation for Space Data Systems Standards.
Telecommand, Part 2.1: Command Operation Procedures." CCSDS Recommendation,
Blue Book.

Mil-STD-1553B, Aircraft Internal Time Division Command/Response Multiplex Data Bus,
21 September, 1978

Mil-STD 461E, Requirements for the Control of Electromagnetic Interference
Characteristics of Subsystems and Equipment

NASA HDBK 4001. Electrical Grounding Architecture for Unmanned Spacecraft,
February 17, 1998
<http://starbase.msfc.nasa.gov/TSL/dispsearch.htm?agency=NASA&disp=E>

3 REQUIREMENTS

3.1 DEFINITION OF FLIGHT SYSTEM

3.1.1 SYSTEM MODULES

There are three major system modules in the GLAST flight system, a spacecraft module, a Large Area Telescope (LAT) module, and a GLAST Burst Monitor (GBM) module, as shown in Figure 3-1. These modules will be built separately, by different contractors. When integrated, these modules form the GLAST observatory. This document defines the spacecraft interfaces for the GBM. The GBM sensors are illustrated as four, periphery sensors along the bottom of the LAT instrument. However, the GBM actually consists of 12 NaI detectors and 2 BGO detectors. The LAT module's spacecraft interfaces are documented in the LAT SI-SC IRD. Also shown in this figure, is the coordinate system for the observatory.

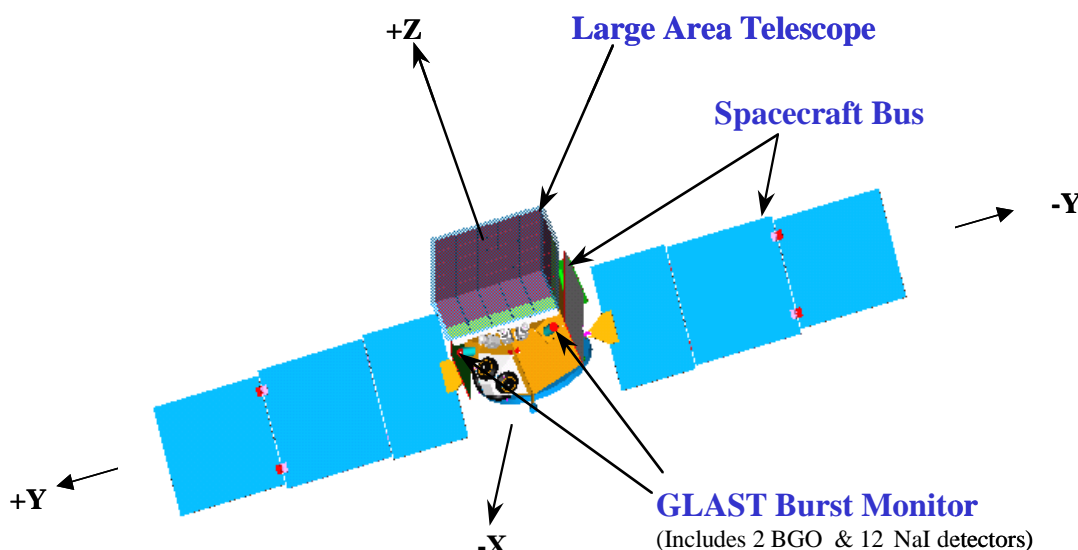


Figure 3-1 Flight System Modules

3.1.2 FLIGHT SYSTEM INTERFACES

The flight system is defined as “everything that flies”, instruments, spacecraft, and launch vehicle. Figure 3-2 shows these components of the flight system and the interfaces between them. It also shows that the flight system has in-flight interfaces with the TDRSS communications satellite system, with direct ground stations, and with the constellation of GPS satellites.

Arrows are used in the figure to indicate generally an accommodation requirement. The spacecraft must directly accommodate the launch vibration environment, fairing envelope, and mounting configuration of the payload attach fitting. While on the launch pad, it receives umbilical power and communicates through the umbilical for command and telemetry. The instruments also have direct interfaces with the launch vehicle in that they must accommodate the radiatively coupled launch environment (acoustics, pressure, and temperature) and the fairing envelope. Otherwise, the spacecraft must accommodate the instruments' mechanical mounting and field of view requirements, as well as their thermal interface requirements. Additionally, the spacecraft provides power services and command and telemetry services to the instruments. Although an overview of the spacecraft interfaces is given, only the specific spacecraft interfaces which pertain to the secondary instrument, GBM, are addressed in this document. All other spacecraft interfaces are specified in the LAT SI-SC IRD. The data transfer and command interfaces between the LAT and the GBM instruments are implemented via the spacecraft's C&DH subsystem. Excluding a GBM "burst trigger" signal which directly

interfaces to the LAT (TBR), all data sent from the GBM instrument must first pass through the C&DH subsystem. The C&DH subsystem shall determine where and when the GBM instrument's data shall be sent. The spacecraft interfaces with direct ground stations for the downlink of high rate telemetry data. It interfaces with TDRSS when communications are needed at unscheduled times or when coverage is needed over a greater portion of the orbit than the direct downlink provides. The demand access service of TDRSS is used for unscheduled alert transmissions, both safe mode and transient events, and for unscheduled target-of-opportunity commanding. Extended coverage is needed during launch and early orbit operations, during any safe mode contingency operations, and for servicing the science instruments (diagnostics, software uploads).

Finally, the spacecraft receives time and position services continuously throughout the mission from the GPS. The spacecraft distributes a pulse-per-second signal via hardware to provide an accurate time mark.

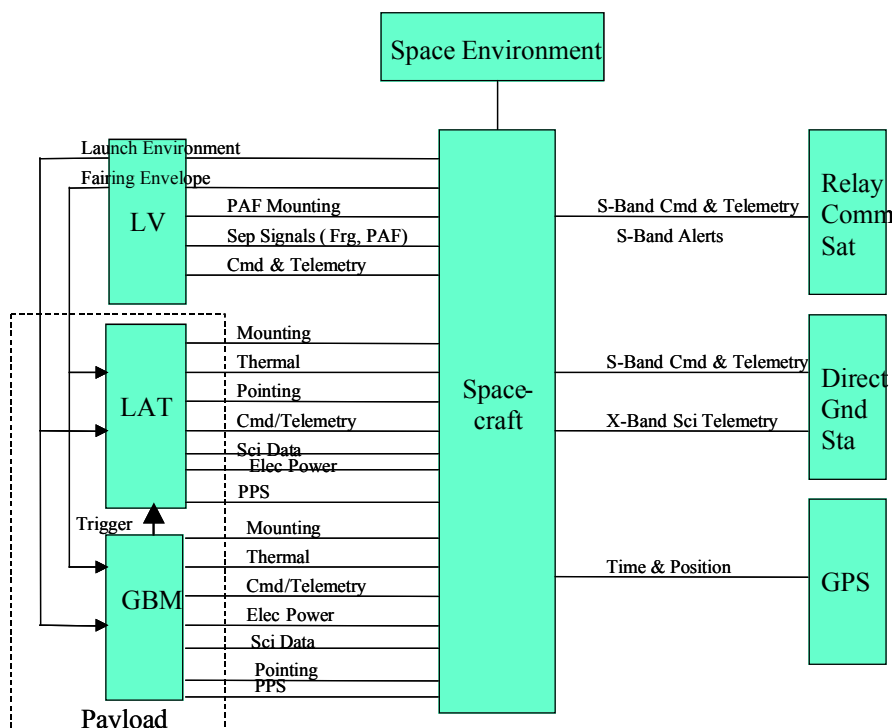


Figure 3-2 Flight System Interfaces

3.2 INTERFACE REQUIREMENTS AND CONSTRAINTS

3.2.1 GENERAL INTERFACE REQUIREMENTS

3.2.1.1 Axes Definitions

The GBM shall use the same axes, defined below, as the LAT and SC.

Both the LAT and GBM science instruments shall use a common definition of right-handed orthogonal axes as shown previously in Figure 3-1. The Z-axis passes through the geometric center of the LAT and SC. This axis is defined as the boresite axis of the observatory. The Y-axis is perpendicular to the Z-axis and is aligned with the axis of solar array rotation. The X-axis is orthogonal to the Y and Z-axes. The observatory will maintain the sun line in the X-Z plane on the +X axis in the normal operating modes.

3.2.1.2 Celestial Coordinates

The observatory shall use celestial coordinates relative to the J2000 coordinate frame. Pointing commands to the observatory and pointing directions reported by the observatory shall be by Right Ascension (RA) and Declination (Dec) in J2000 coordinates.

3.2.1.3 Pointing Knowledge

The observatory shall be capable of pointing in any direction at any time, autonomously or by ground command, to the accuracy specified in the Science Requirements Document. The knowledge of the observatory pointing direction at any time, including during slew, shall be such that the total error is < 6 arcminutes [1σ diameter]. This error budget includes:

- The intrinsic resolution of the star tracker system

- The relative alignment of the star tracker system between each GBM NaI detector's reference surface.

- The relative alignment of the star tracker system between each GBM BGO detector's reference surface, 1 degree (TBD).

- The relative alignment of the star tracker system and the GBM NaI detectors cannot be calibrated on orbit.

The stability of the relative alignment between the star tracker system and the GBM's NaI reference surface, including all thermal-mechanical effects, shall be TBD throughout the mission and allocated as specified in the Mission System Specification.

The observatory's pointing knowledge budget shall be allocated as specified in the Mission System Specification.

3.2.1.3.1 Jitter

Over periods of less than 200 milliseconds, the jitter shall be less than 1 arcsec (TBR), 1σ , radial.

3.2.1.4 Fairing Envelope Constraint

The fairing envelope constraints shall be followed as shown in the reference document, Delta II Payload Planners Guide for the 3-meter fairing.

3.2.2 MECHANICAL

3.2.2.1 Envelope of GBM

The TBD figure shows regions for access to the instrument for electrical integration and test with the spacecraft. These access regions shall not be occluded by any permanent SC structures.

Figure 3-3 (TBD): Illustrate DPU, LVPS, HVPS, 2 BGO detectors, and 12 NaI detectors

3.2.2.2 Math Models

Mathematical models shall be readily exchanged electronically between the GBM and SC contractors and the GSFC. This requires the use of common design tools and versions for file format compatibility. Alternate formats are acceptable only when approved by the Project Office. Exchange of mechanical design information shall primarily use the IGES neutral file format (bounded surface models). Other formats, such as STEP file format, may also be required.

3.2.2.3 Mounting Hardware

The SC shall provide mounting hardware for GBM detector system. The GBM detector system's mounting hardware mass shall be included in the SC mass allocation. The GBM detector system consists of all NaI detectors, BGO detectors, flight harnessing (provided by the SC), and electronic boxes.

NaI Detectors: Mounting with FOV requirements

In the deployed configuration on-orbit and during ground testing, the direction to any point in the sky within 120 degrees (TBC) of the +Z axis shall be <80 degrees (TBC) from the normal vectors of at least 3 unobstructed non-collinear NaI detectors, with 95% probability; the goal is 4 unobstructed detectors with 100% probability. Solar arrays are not considered obstructions. The angle between the normals of any two NaI detectors shall be <25 degrees (TBC).

BGO Detectors: Mounting with FOV requirements

In the deployed configuration on orbit and during ground testing, at least one unobstructed BGO detector shall be visible from any point in the sky within 120 degrees of the +Z axis, with 95% probability (the goal is 100% probability over all directions).

Solar arrays are not considered obstructions. The axis of symmetry of the BGO detectors should be perpendicular to the +Z axis.

The SC shall provide and accommodate the routing of all electrical cables and dedicated thermal links between the SC and GBM as well as provide access to such components for integration.

3.2.2.4 GBM Mass Constraint

The maximum launch mass of the entire GBM detector system shall be constrained to 70 kg, as allocated in the Mission System Specification. The GBM detector system's launch mass includes all GBM hardware mounted on the SC bus, such as detectors and electronics boxes. The GBM detector system's maximum launch mass excludes flight harnessing, thermal radiators (TBR), and detector mounting hardware.

3.2.2.5 Center of Gravity Constraints

While meeting the observatory center of gravity constraint, the spacecraft shall accommodate the center of gravity locations of the GBM.

3.2.2.6 Clear Field of View

The GBM field of view shall be as specified in the SRD.

3.2.2.7 Alignment

The relative alignment of the star tracker system and each of the GBM's NAI detector reference surfaces shall be surveyed on the ground and maintained to < TBD degrees [TBD σ diameter] during environmental testing and launch to orbit. The total error must be < 6 arcminutes [1 sigma diameter].

3.2.2.8 Structural Design Requirements

3.2.2.8.1 Stiffness

The fixed base stiffness of each GBM detector shall produce a first mode frequency greater than 50 Hz (TBR).

3.2.2.8.2 Static Load Design

The design of the GBM mounting structure and GBM components shall use a limit load factor of ± 12.0 g applied to each axis independently.

3.2.2.8.3 Factors of Safety

Factors of safety are multiplicative factors that are applied to limit loads to evaluate the yield and ultimate strength levels of the structural design. Guidelines for the appropriate use of factors of safety are given in the referenced GEVS-SE Rev A document.

3.2.2.8.4 Component Evaluation Random Vibration

The evaluation of components shall use the generalized random vibration power spectral density in GEVS-SE.

3.2.2.8.5 Acoustics

The acoustic spectrum is given in GEVS-SE for the Delta II launch vehicle.

3.2.2.8.6 Pyroshock

The pyroshock spectrum is given in GEVS-SE for the Delta II launch vehicle.

3.2.2.8.7 Finite Element Model

A finite element model of the GBM shall be delivered electronically by February 28, 2001 (TBR) to the GLAST Project Office at GSFC. This model is required so that the SC contractor may combine a finite element model of the SC and perform a preliminary coupled loads analysis.

3.2.2.8.8 Observatory Level Integration and Testing

As specified in the LAT IRD, during observatory level integration and testing, the observatory's +Z-axis shall be oriented towards the earth (i.e. - the observatory shall be oriented upside down).

The GBM's handling procedures during observatory integration and testing are TBD.

3.2.3 THERMAL

3.2.3.1 GBM Thermal Design

The design and performance of the GBM thermal system shall be the responsibility of the GBM engineering team. The GBM thermal system includes all dedicated GBM radiating surfaces that may be located on the SC module as well as all thermal interfaces and links that transport heat from these surfaces to the GBM. The radiators shall be sized to allow for heat backloading from the solar arrays, Earth IR, and UV albedo energy.

3.2.3.1.1 Passive Thermal System

The GBM will employ a passive thermal system with heater control. The GBM thermal sub-system is defined to include all GBM surfaces that effect the GBM heat balance.

The GBM thermal system is defined to include all GBM surfaces and thermal links that effect the GBM heat balance.

3.2.3.1.2 Thermal Isolation

The GBM and SC modules shall be thermally isolated. The SC shall provide the thermal isolation hardware. A maximum of +TBD watts conductive heat flow shall be permitted to flow from the SC to the GBM through the interface support structure and all cabling at the worst-case operational temperature range limits of the GBM and SC. Preliminary thermal design shall use the environmental parameters of Table 3-2.

Table 3-2 Thermal Design Parameters

Thermal Flux Source	Hot Case	Cold Case
Solar Constant	1419 W/m ²	1286 W/m ²
Albedo Factor	0.40	0.25
Earth IR	265 W/m ²	208 W/m ²

3.2.3.2 Maximum Operating Temperature for the Data Processing Unit (DPU), Low Voltage Power Supply (LVPS), and High Voltage Power Supply (HVPS)

The maximum operational temperature of the GBM detector system shall not exceed +50°C.

3.2.3.3 Minimum Operating Temperature for DPU, LVPS, and HVPS

The minimum operational temperature of the GBM detector system shall be not be less than -20°C.

3.2.3.4 Survival Temperature for DPU, LVPS, and HVPS

The minimum survival temperature shall not be less than -30° C .

3.2.3.5 Ground Storage Temperature for DPU, LVPS, and HVPS

The ground storage temperature shall not be less than -30°C and shall not exceed +70° C.

3.2.3.6 Humidity

The relative humidity during ground testing shall not be less than 10% and shall not exceed 80% (TBC).

3.2.3.7 Thermal Verification Requirements

Thermal/vacuum test environments for GBM and SC verification testing, as well as GBM/SC combined verification tests shall be according to GEVS-SE Rev A.

3.2.4 ELECTRICAL

3.2.4.1 GBM Flight Harness

The SC shall provide all GBM flight harnesses. The flight harness length between the GBM's Data Processing Unit (DPU) and any other component (i.e. - GBM detector, solid state recorder, etc.) shall not exceed 4 meters (TBR).

3.2.4.2 Bus Voltage

The bus voltage supplied to the GBM shall be $28\text{ V} \pm 6\text{ V}$ as seen at the input terminals of the GBM. The GBM shall perform when subjected to voltage transients per requirements specified in TBD. Under abnormal conditions the GBM shall survive, without permanent degradation, steady-state voltages in the range: $0 < V < 38$ (TBR) VDC.

3.2.4.3 Bus Current

3.2.4.3.1 Overcurrent Protection

The spacecraft shall provide protection of the spacecraft power system by providing overcurrent protection devices on each GBM power connection. The sizes and characteristics of the overcurrent protection devices shall be TBD.

3.2.4.3.2 GBM Current Transients

The following GBM requirements shall be measured when supplied by a voltage source having the impedance characteristics of the spacecraft power source:

GBM current peaks associated with both turn-on inrush current and non-repetitive operational current transients shall not exceed TBD

During normal operations the GBM shall limit current transient rate of change to TBD.

The GBM shall limit turn-on inrush current transient rate of change to TBD.

The GBM shall limit turn-off current transient rate of change to TBD.

3.2.4.4 Impedances

3.2.4.4.1 Power Source Impedance

The PSE output impedance shall be less than 70 milli-ohms to 3kHz (TBR).

3.2.4.4.2 GBM Power Input Impedance

The GBM power input filter shall present a symmetrical common mode and differential mode impedance to the power bus, as represented by the AC impedance of the differential mode and common mode input filters.

3.2.4.4.3 GBM Common Mode Impedance

TBD

3.2.4.4.4 GBM Differential Mode Impedance

TBD

3.2.4.5 Power Constraints

3.2.4.5.1 Peak Power

The GBM instrument's peak power shall not exceed 55 Watts.

3.2.4.5.2 Peak Power Duration

The maximum duration for the peak power dissipation of the GBM shall not exceed 3 minutes (TBD) for each orbit.

3.2.4.5.3 Average Power

The average power dissipation of the GBM instrument shall not exceed 50 Watts per orbit.

3.2.4.6 Primary Power Distribution

The SC shall provide one prime and one redundant switched service to the GBM. These services are mutually exclusive in that only one is active at a time. However, the design of the GBM shall preclude damage to the GBM if both services are active at the same time. The design of the GBM shall also preclude damage to the GBM if power is removed instantaneously without warning.

3.2.4.7 Survival Heater Power Bus

The SC shall provide a separate, redundant Survival Heater Power Bus to the GBM. Survival power is used only for heaters and associated passive control circuitry that maintain the GBM at a minimum turn-on temperature. Each side of the Survival Heater Power Buses shall be continuously powered during flight. Survival heaters shall be redundant. Survival heaters shall be electrically isolated from each other and from chassis. Survival heaters shall have independent power returns. The GBM's survival heater power shall not exceed TBD W.

3.2.4.8 Isolation

The GBM shall provide secondary power converters that isolate secondary from primary power returns. Secondary returns shall be isolated from primary returns by $> 1 \text{ M}\Omega$ (TBR) at dc except for the heater bus.

3.2.4.9 Grounding

The observatory shall employ a “hard-grounded” primary ground system with multiple connections in the secondary systems. Figure 3-3 shows the configuration of the ground system. Observatory structure or an electrically conductive ground plane, known as chassis ground, shall provide the ground reference. The primary power system shall be connected to chassis ground at a single point at dc by $< 10 \text{ m}\Omega$ resistance(s) and at ac by an impedance of TBD k Ω . Secondary loads shall each be referenced to chassis ground by a single connection. The chassis ground system shall not be used to conduct load current. The maximum ungrounded surface area, e.g., for MLI, shall be $< 10 \text{ cm}^2$ (TBR).

Figure 3-4. Single Reference Ground System with Multiple Connections (TBD)

3.2.4.10 EMC

The SC shall be consistent with the Electromagnetic Compatibility (EMC) guidelines defined in the General Environmental Verification Specification for STS and ELV Payloads, Subsystems, and Components (GEVS-SE) and the Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment (MIL-STD-461E). Detailed requirements shall be documented in the GLAST EMC Requirements (TBD) document.

3.2.4.11 C&DH Interfaces

This section describes the physical interface requirements for the C&DH services, which include the science data, command and telemetry, time mark and frequency and any discrete interfaces.

3.2.4.11.1 Interface Conductors

Signal conductors shall use paired conductors. Paired conductors may include twisted pair, coaxial, twin axial, and dual coaxial types.

3.2.4.11.2 Interface Circuitry Isolation

TBD

3.2.4.11.3 Physical Characteristics of Interface Signals

TBD

3.2.4.12 Test Point Interfaces

The SC or GBM may elect to use test points to provide external access to internal circuitry via GSE. Use of test points shall meet the following requirements.

3.2.4.12.1 Spacecraft Integration and Test Use

Test points shall not be used during spacecraft integration and test, except as expressly approved and documented in formal procedures.

3.2.4.12.2 Performance Verification Limit

Data collected to verify acceptance or qualification of performance requirements shall be acquired through flight interfaces and not through test point interfaces.

3.2.4.12.3 Keyed Connectors

All test points shall be brought out to a separated, keyed connector(s), which shall be easily accessible.

Separate test connectors shall be used to segregate classes of signals. When not in use and prior to launch, the connectors shall be protected with flight qualified covers.

3.2.4.12.4 Power and Load Isolation

The observatory shall not be powered through, nor significantly loaded, by test point interface circuitry, including connection to external GSE.

3.2.4.12.5 Failure Propagation

Test point interface circuitry shall not propagate failures to flight circuitry. This includes credible failures in GSE connected externally to the test point interface connectors.

3.2.4.12.6 Short-Circuit Isolation

Test point short-circuit isolation shall also be provided. The observatory shall operate within specification in the event any test point is shorted to the power bus, ground, or another test point, and upon removal of the short.

3.2.4.12.7 Grounding Integrity

Test point interface circuitry shall not compromise grounding requirements, either by design or use.

3.2.4.12.8 Flight Standards

Test points shall be designed and implemented in accordance with all applicable flight standards and component ratings.

3.2.4.12.9 Test Point Documentation

Test point interfaces, functions and GSE interconnection shall be documented in TBD.

3.2.5 GBM AND C&DH DATA SERVICES

3.2.5.1 Command, Telemetry, and Data Bus

Commands, telemetry, time message, and ancillary data shall be transferred between the GBM and the C&DH via a serial command, telemetry, and data (CTDB) bus as defined by MIL-STD-1553B.

3.2.5.1.1 CTDB Protocol

CTDB data shall utilize the physical communications layer as defined by MIL-STD-1553B.

3.2.5.1.1.1 Command Data

Commands transferred over the CTDB shall be formatted per CCSDS 203.0-B-1, "Recommendations for Space Data Systems Standards. Telecommand, Part 3: Data Management Service" CCSDS Recommendation, Blue Book.

3.2.5.1.1.2 Telemetry Packets

Telemetry packets transferred over the CTDB shall be formatted per CCSDS 102.0-B-4 (Packet Telemetry Blue Book).

3.2.5.2 GBM Housekeeping Data

The GBM shall provide the C&DH, upon request, a housekeeping data set as defined in the GBM Telemetry Format Document (TBR).

3.2.5.3 Pulse per Second Bus

The C&DH shall provide the GBM a pulse-per-second (PPS) signal accurate to ± 0.5 μ sec (TBR) referenced to the on-board GPS receiver.

3.2.5.4 Time Distribution to GBM

The SC C&DH shall issue a time message that gives Universal Coordinated Time (UTC) (TBR).

3.2.5.5 GPS Receiver Time Dropout

The PPS signal shall be provided, without interruption, to the GBM in the event of a loss of the time signal provided by the GPS receiver.

3.2.5.6 PPS Signal Drift

The PPS signal shall drift no more than ± 1 μ second over a period of 100 seconds when a GPS time signal loss occurs.

3.2.5.7 Time Message Distribution

The Time Mark Message shall be issued no more than 100 milliseconds (TBR) after the transition of the 1 PPS time mark signal.

3.2.5.8 Ancillary Data

The C&DH shall provide an ancillary data packet to the GBM at the attitude control loop rate of 5 Hz (TBR). The ancillary data packet shall contain data as specified in the Data Format Document (TBS). Ancillary data packets shall include 1) the time-tagged attitude vector; 2) the time-tagged orbit position vector; and 3) attitude and position vector rates based on GPS data processed by the ACS.

3.2.5.9 Analog Signals

The C&DH shall provide 16 primary and 16 redundant analog channels for monitoring GBM health and safety.

3.2.5.10 Discrete Control Signals

The C&DH shall provide 16 (TBR) primary and 16 (TBR) redundant discrete pulse signals channels for configuration and power control of the GBM.

3.2.5.11 Discrete Monitor Ports

The C&DH shall provide 16 (TBR) primary and 16 (TBR) redundant discrete monitor ports for monitoring configuration status of the GBM.

3.2.5.12 GBM Command Storage

The C&DH shall provide 8 kbytes (TBR) of stored command memory for GBM utilization.

3.2.5.13 GBM Command Frequency

The C&DH shall transmit commands to the GBM at a maximum rate of TBD commands per second.

3.2.5.14 GBM Configuration Commands

The GBM shall be configured by commands issued by the C&DH.

3.2.5.15 GBM Table Loads

The GBM shall load internal tables from commands issued by the C&DH.

3.2.5.16 GBM Memory Loads

The GBM software shall be reprogrammable via software load commands.

3.2.5.16.1 Memory Load Rate

Memory loads shall be provided to the GBM at 4 kbps (TBR) for TDRSS contacts and 2 kbps (TBR) for ground station contacts.

3.2.5.16.2 GBM Memory Dumps

Commands shall allow dumps from GBM program memory, data memory, or both.

3.2.5.16.3 GBM Trigger Signal to LAT

The GBM shall provide an RS-422 trigger signal to the LAT at a rate not to exceed 1 pulse per second (TBR).

3.2.5.17 Transient Event Repointing

The requirements in this subsection are based on the following system concept. Transient event repointings may interrupt the normal observation modes, viz., sky survey and pointed observations. These interruptions are under the control of an enable. They are inhibited if a telemetry contact is scheduled within the allowed duration of the repointing command. Secondary targets during earth occultation are not used during transient event repointings.

Currently, there are four possible sources of repointing commands, 1) target of opportunity commands via the Science Operations Center, 2) detection of high energy gamma-ray burst by the LAT instrument, 3) detection of low energy gamma-ray bursts by the GBM instrument, and 4) detection of active galactic nuclei by the LAT instrument. The direction of repointing is determined by the source of the command. All command sources shall use the coordinate reference frame as specified in Section 3.2.1.2 Celestial Coordinates of this document. The duration of repointing is presently the same for all sources and is set by ground command. However, it could be different for each type of transient, and it could be set by the source of the command. Finally, a go-no go decision needs to be made based on current pointing direction, proposed repointing direction, time to slew, and viewing solid angle. Where this decision is made is currently TBD.

3.2.5.17.1 Repointing Control Enable

When enabled, the SC shall issue a repointing command to the ACS that supercedes the last SC-generated pointing command. The SC C&DH shall report status to the GBM in the ancillary data packet.

3.2.5.17.2 Transient Alerts to Ground

Per the Science Requirements Document, the GBM shall generate and send a transient alert message to the SC and a "burst alert trigger" signal to the LAT. Upon receipt of a transient alert message from the GBM, the SC shall transmit the transient alert message to the ground within 1 second (TBR).

3.2.5.17.3 Pointing Coordinates

Transient alert message shall contain the pointing direction coordinates as specified in in Section 3.2.1.2 of this document.

3.2.5.17.4 Transient Event Pointing Commands

The C&DH shall issue a transient event repointing command, derived from the alert message, to the SC ACS that contains the direction and duration of the transient event.

3.2.6 SCIENCE DATA INTERFACE

3.2.6.1 Science and Housekeeping Data

The GBM shall output science and telemetry data via separate data bus interfaces. The minimum capacity of the GBM science data buffer shall be 2.2 gigabits (TBR), including 20% Reed-Solomon encoding overhead.

3.2.6.1.1 High-Speed DataBus (HSDB) Rates

The GBM-SC data rate on the dedicated science data interface shall accommodate data transfer rates up to 12 Mbps.

The high rate interfaces shall be implemented in a flight-proven or flight-qualified technology which meets the GLAST mission requirements, e.g. parallel RS-422, IEEE 1393, etc.

3.2.6.1.2 Packet Format

All GBM data transferred over the HSDB shall be formatted per CCSDS 102.0-B-4 (Packet Telemetry Blue Book).

3.2.6.1.3 Packet Size

The GBM shall utilize variable length CCSDS source packets (TBR) up to a maximum length of 65536 octets.

3.2.7 FAULT PROTECTION

3.2.7.1 Fault Tolerance

SC and GBM systems and interfaces shall be single-fault tolerant.

3.2.7.2 Safe Mode

The SC shall enter safe mode when a mission critical fault is detected and cannot be corrected by on-board processes.

3.2.7.3 Safe Mode Notification

The C&DH shall send the GBM a message via the CTDB indicating transfer into safe mode except when the mission critical fault is loss of the C&DH.

3.2.7.4 Load Shedding

GBM power shall be disconnected when ground-based or on-board fault analysis determines load shedding is required.

3.2.7.5 Load Shedding Notification

The C&DH shall provide a message to the GBM, via the CTDB, 15 seconds (TBR) prior to issuing a command to disconnect GBM power.